Assessment of Radiolytic Hydrogen as an Energy Source for Life in Subseafloor Sediments

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Molecular hydrogen and oxidants produced by the radiolysis of water may provide a continuous source of energy to subsurface microbial communities (Pedersen, 1999). We assessed the importance of this process in subseafloor sediments of the equatorial Pacific and the Peru Margin by calculating potential radiolytic H_2 production rates and comparing them to estimates of net respiration. H_2 production rates were calculated using downhole logging estimates of uranium, thorium, and potassium abundances, shipboard measurements of porosity and density, and a model of water radiolysis. Hydrogen yields for drilled sections of the sediment column ranged from $4x10^{-9}$ to $4x10^{-8}$ mols/yr/cm^2-sediment; Peru Margin sites had higher yields and equatorial Pacific sites had lower yields. For the sites at which we can estimate radiolytic hydrogen yield and net respiration for the column as a whole, the ratio of radiolysis to net respiration ranges from 3/1000 to 3/100. This ratio may be higher for sediments deeper in these columns, because respiration generally decreases with increasing depth while radiolysis occurs throughout the column. More broadly, radiolysis of water may be a significant source of energy for modern ecosystems in subseafloor sediments with very low organic carbon content. If so, these non-photosynthetic ecosystems may be useful as models for Earth's earliest sedimentary ecosystems and sedimentary ecosystems on other planets.